

IN THE CLAIMS:

Claims 18 and 30 were previously cancelled. None of the claims have been amended herein. All of the pending claims are presented below. This listing of claims will replace all prior versions and listings of claims in the application. Please enter these claims as amended.

1. (Previously presented) A method of forming a barrier layer on a surface of a semiconductor device structure, comprising:  
providing a semiconductor substrate;  
forming a dielectric layer over the semiconductor substrate, the dielectric layer having at least one trench;  
selectively depositing a metallization layer in the at least one trench; and  
forming a contiguous barrier layer overlying the metallization layer and the dielectric layer, the barrier layer comprising at least one conductive portion over the metallization layer and at least one nonconductive portion over the dielectric layer, wherein the contiguous barrier layer is parallel to and substantially coextensive with a top surface of the metallization layer.

2. (Previously presented) The method of claim 1, wherein forming the dielectric layer over the semiconductor substrate comprises forming the dielectric layer from an oxide compound, an aerogel, or a polymer.

3. (Previously presented) The method of claim 2, wherein forming the dielectric layer over the semiconductor substrate comprises forming the dielectric layer from a polymer selected from the group consisting of a foamed polymer, a fluorinated polymer, and a fluorinated-foamed polymer.

4. (Previously presented) The method of claim 2, wherein forming the dielectric layer over the semiconductor substrate comprises forming the dielectric layer from polyimide.

5. (Previously presented) The method of claim 2, wherein forming the dielectric layer over the semiconductor substrate comprises forming the dielectric layer from silicon oxide.

6. (Previously presented) The method of claim 1, wherein selectively depositing the metallization layer in the at least one trench comprises selectively depositing copper or a copper alloy.

7. (Previously presented) The method of claim 1, wherein forming the barrier layer overlying the metallization layer and the dielectric layer comprises depositing a metal layer over the metallization layer and the dielectric layer.

8. (Previously presented) The method of claim 7, wherein depositing the metal layer over the metallization layer and the dielectric layer comprises depositing a metal selected from the group consisting of titanium, zirconium, and hafnium.

9. (Previously presented) The method of claim 7, wherein depositing the metal layer over the metallization layer and the dielectric layer comprises depositing the metal layer by low energy implantation or chemical vapor deposition.

10. (Previously presented) The method of claim 7, wherein depositing the metal layer over the metallization layer and the dielectric layer comprises selecting an implant energy so that the metal layer penetrates a surface of the metallization layer and of the dielectric layer.

11. (Previously presented) The method of claim 10, wherein selecting the implant energy so that the metal layer penetrates the surface of the metallization layer and of the dielectric layer comprises selecting the implant energy to be from about 0.1 keV to about 2.0 keV.

12. (Previously presented) The method of claim 7, wherein depositing the metal layer over the metallization layer and the dielectric layer comprises selecting an implant energy so that the metal layer penetrates a depth of from about 5Å to about 50Å into the metallization layer and the dielectric layer.

13. (Previously presented) The method of claim 7, wherein forming the barrier layer overlying the metallization layer and the dielectric layer comprises reacting at least a portion of the metal layer with nitrogen to form the barrier layer.

14. (Previously presented) The method of claim 7, wherein forming the barrier layer overlying the metallization layer and the dielectric layer comprises exposing the metal layer to a nitrogen atmosphere.

15. (Previously presented) The method of claim 14, wherein exposing the metal layer to the nitrogen atmosphere comprises exposing the metal layer to the nitrogen atmosphere for an amount of time sufficient to incorporate nitrogen into at least a portion of the metal layer.

16. (Previously presented) The method of claim 14, wherein exposing the metal layer to the nitrogen atmosphere comprises exposing the metal layer to nitrogen, nitric oxide, nitrous oxide, or ammonia.

17. (Previously presented) The method of claim 14, wherein exposing the metal layer to the nitrogen atmosphere comprises exposing the metal layer to a nitrogen plasma or a rapid thermal nitrogen treatment.

18. (Canceled)

19. (Previously presented) The method of claim 7, wherein forming the barrier layer overlying the metallization layer and the dielectric layer comprises reacting nitrogen with a first portion of the metal layer to form at least one metal nitride portion.

20. (Previously presented) The method of claim 7, wherein forming the barrier layer overlying the metallization layer and the dielectric layer comprises reacting a second portion of the metal layer with the dielectric layer to form at least one metal oxide portion, metal oxynitride portion, metal carbide portion, or metal carbonitride portion.

21. (Previously presented) A method of forming a barrier layer on a surface of a semiconductor device structure, comprising:  
providing a semiconductor substrate;  
forming a dielectric layer over the semiconductor substrate, the dielectric layer having at least one trench;  
selectively depositing a metallization layer in the at least one trench;  
depositing a metal layer overlying the metallization layer and the dielectric layer; and  
exposing the metal layer to a nitrogen atmosphere to form a contiguous barrier layer overlying the metallization layer and the dielectric layer, the contiguous barrier layer comprising at least one conductive portion over the metallization layer and at least one nonconductive portion over the dielectric layer, wherein the contiguous barrier layer is parallel to and substantially coextensive with a top surface of the metallization layer.

22. (Previously presented) The method of claim 21, wherein depositing the metal layer overlying the metallization layer and the dielectric layer comprises depositing a metal selected from the group consisting of titanium, zirconium, or hafnium.

23. (Previously presented) The method of claim 21, wherein depositing the metal layer overlying the metallization layer and the dielectric layer comprises depositing the metal layer by low energy implantation or chemical vapor deposition.

24. (Previously presented) The method of claim 21, wherein depositing the metal layer overlying the metallization layer and the dielectric layer comprises selecting an implant energy so that the metal layer penetrates a surface of the metallization layer and the dielectric layer.

25. (Previously presented) The method of claim 24, wherein selecting the implant energy so that the metal layer penetrates the surface of the metallization layer and the dielectric layer comprises selecting the implant energy to be from about 0.1 keV to about 2.0 keV.

26. (Previously presented) The method of claim 21, wherein depositing the metal layer overlying the metallization layer and the dielectric layer comprises selecting an implant energy so that the metal layer penetrates a depth of from about 5Å to about 50Å into the metallization layer and the dielectric layer.

27. (Previously presented) The method of claim 21, wherein exposing the metal layer to the nitrogen atmosphere comprises exposing the metal layer to the nitrogen atmosphere for an amount of time sufficient to incorporate nitrogen into at least a portion of the metal layer.

28. (Previously presented) The method of claim 21, wherein exposing the metal layer to the nitrogen atmosphere comprises exposing the metal layer to nitrogen, nitric oxide, nitrous oxide, or ammonia.

29. (Previously presented) The method of claim 21, wherein exposing the metal layer to the nitrogen atmosphere comprises exposing the metal layer to a nitrogen plasma or a rapid thermal nitrogen treatment.

30. (Canceled)

31. (Previously presented) The method of claim 21, wherein exposing the metal layer to a nitrogen atmosphere to form a barrier layer overlying the metallization layer and the dielectric layer comprises reacting nitrogen with the metal layer to form at least one metal nitride portion of the barrier layer.

32. (Previously presented) The method of claim 21, wherein exposing the metal layer to a nitrogen atmosphere to form a barrier layer overlying the metallization layer and the dielectric layer comprises reacting the metal layer with the dielectric layer to form at least one metal oxide portion, metal oxynitride portion, metal carbide portion, or metal carbonitride portion of the barrier layer.